COMPRESSIVE STRENGTH AND SPLITTING TENSILE STRENGTH OF OIL PALM SHELL LIGHTWEIGHT AGGREGATE CONCRETE CONTAINING COAL BOTTOM ASH

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Abu dasar arang batu (CBA) ialah sisa daripada loji tenaga haba arang batu. Sementara itu, tempurung kelapa sawit (OPS) adalah bahan buangan daripada industri kelapa sawit. Kebiasaanya, kedua-dua bahan ini tidak mempunyai sebarang kegunaan terhadap industri-industri tersebut dan akan ditempatkan di tempat pelupusan sampah. Peningkatan jumlah OPS dan CBA membawa kepada kajian ini untuk menggunakan bahan buangan tersebut di dalam pembuatan konkrit. Penggantian pasir sungai dengan bahan buangan industri daripada arang batu di dalam konkrit aggregat ringan dengan OPS dapat dibuktikan bermanfaat secara teknikal dan ekonomi terhadap industri pembinaan. Menurut kajian ini, beberapa ujian makmal telah dijalankan untuk mengetahui kesan abu dasar arang batu sebagai bahan penggantian pasir sungai terhadap sifat-sifat mekanikal dalam konkrit aggregat ringan. Pasir sungai telah digantikan dengan abu dasar arang batu mengikut berat 0, 10, 20 dan 30% darjah penggantian. Kesemua spesimen diawet menggunakan kaedah pengawetan udara sehingga 60 hari. Ujian-ujian makmal yang terlibat dalam kajian ini adalah kekuatan mampatan dan kekuatan tarik terpecah. Keputusan ujian menunjukkan penggantian CBA sebanyak 10% merekodkan bacaan kekuatan tertinggi pada ujian kekuatan mampatan dan kekuatan tarik terpecah pada semua usia pengawetan. Sementara itu, penggantian separa CBA yang melebihi 10% mengurangkan kekuatan konkrit.

ABSTRACT

Coal bottom ash (CBA) is a residue of coal thermal power plant. Meanwhile, oil palm shell (OPS) is a by-product of oil palm industries. Usually, both of this materials have no use towards this industries and being abandon at landfill. The increment amount of OPS and CBA lead to this research to make use of this waste product in concrete making. The replacement of river sand with industrial by-products of coal in OPS lightweight aggregate concrete can prove both technically and economically beneficial to the construction industry. In this research, laboratory tests have been conducted to find out the effect of coal bottom ash as a substitute material of river sand towards mechanical properties in lightweight aggregate concrete. River sand was substituted with coal bottom ash by mass in concrete at 0, 10, 20, and 30% replacement level. All of these specimen are subjected to air curing up to 60 days. The tests involved in this research are compressive strength test and splitting tensile strength test. The test results show that at 10% of CBA replacement give the highest reading of compressive and splitting tensile strength at all curing age. Meanwhile, partial replacement of CBA greater than 10% decrease the concrete strength.

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LIST OF SYMBOLS

P	Maximum load failure
A	Cross-sectional area of cube
L	Length of specimen
D	Diameter of specimen

LIST OF ABBREVIATIONS

OPS	Oil palm shell
CBA	Coal bottom ash
LWAC	Lightweight aggregate concrete
ASTM	America Society Testing and Materials
BS	British Standard

CHAPTER 1

INTRODUCTION

1.1 Introduction

Concrete was a mixture of cement, aggregates, sand and water that widely used in construction. This mixture would go through a chemical reaction called hydration process producing Calcium Silicate Hydrate gel (CSH) and Calcium Hydroxide ($Ca(OH)_2$) which make them hardened and gained its strength to form a strong solid. Components of concrete that consist of cement and aggregates were produced from limestone rocks where it required process of blasting in order to obtain the raw material. As this raw materials were non-reproducible, producing concrete materials not just costly but also would reduce the natural resources of limestone rocks. In this case, several studies had been done in order to replace and minimize the usage of cement and aggregates material in producing concrete to ensure this natural resources could be preserved. Waste material that has likely the same properties had been proposed as another option in replacing cement and aggregate in concrete.

Globally, 998 million tonnes of agricultural waste was produced per year and in Malaysia, 1.2 million tonnes of agricultural waste was disposed of into landfills annually (Agamuthu et al., 2009). The waste that being ended up at landfill had no used and created another problems to environment and human being. Approximately 30,000 tonnes of municipal solid wastes were generated daily, covering 83% of the country's waste generation, including agro wastes. About 95% of the total wastes were sent to landfills for disposal (Fauziah and Agamuthu, 2011). Malaysia was one of the biggest producer and exporter of oil palm industries in the world. This activity had brought up a large number of oil palm waste as it got no use towards this industry. The large amounts of untreated waste from agriculture and industrial sectors contaminate land, water and air

by means of leaching, dusting, and volatilization. In this case, a study over oil palm shell had been proposed to use it as a replacement for concrete materials.

Coal bottom ash (CBA) was one of the biggest sources of industrial wastes that had been produced from thermal power plants (Nikbin et al., 2016). On burning of coal in coal fired boilers, it left behind the various types of ash, some of which were removed from the bottom due to coarser in nature of the furnace (generally known as CBA) and the remaining had been collected in other forms like fly ash and scrubber ash (Kim and Lee, 2015). This waste product usually being dumped into waste area, resulting air pollution and hazardous to human and surrounding. In order to prevent this problem, a study had been proposed to make this material could be used and beneficial to others.

1.2 Problem Statement

Oil palm shell and coal bottom ash were by-product of oil palm and coal industries. In 2007, there was approximately 3 million tonnes of waste product derived throughout the electricity generated process in Malaysia (Lau, 2004). Other than that, this waste materials from coal industries were harmful to environment as it could cause air pollution. Using these material as concrete properties replacement could minimize the effect to the environment. In addition, sand and granite aggregate that commonly used in concrete was produced by sand mining and granite quarrying activities. This action could cause depletion to natural resources as it were non-reproducible resources. Meanwhile, using CBA as sand partial replacement would lessen the dependency towards sand and preserved natural resources. In order to reduce the production and consumption amount of granite aggregate, using OPS as granite aggregate replacement could be a wiser choice. It not only cut down the dependency towards natural resources, but also reduce the amount of wastage that abandon in landfill area.

1.3 Objectives of Research

The objectives of the study as followed:

i. To determine the effect of coal bottom ash (CBA) as a partial sand replacement on dry density and compressive strength of OPS lightweight aggregate concrete.

ii. To determine the effect of coal bottom ash (CBA) as a partial sand replacement on splitting tensile strength of OPS lightweight aggregate concrete.

1.4 Scopes of Research

The main focus of this research were on investigating the mechanical properties of OPS lightweight aggregate concrete containing coal bottom ash (CBA) as partial sand replacement in concrete. The mechanical properties that had been investigated were dry density, compressive strength and splitting tensile strength. In this research, four mixes had been used. A plain OPS concrete containing 100% sand had been used as a control mix. Another mixes were OPS with percent of CBA of 10, 20 and 30 were used as partial sand replacement. All of the samples had undergo air curing and tested for 7, 28 and 60 days.

1.5 Significance of Research

The usage of oil palm shell and coal bottom ash as aggregate and partial sand replacement respectively would reduce large amount of waste that disposed at landfill. In addition, this action also would help to reduce environmental problems related to depletion of natural resources involving granite aggregates and sand. Moreover, this research would help to preserve and minimize the high dependency of construction materials towards natural resources.

1.6 Layout of Thesis

Chapter 1 provided a brief introduction about the main topic of oil palm shell (OPS) lightweight aggregate concrete used and CBA as the partial sand replacement in concrete. This chapter also provided information about the problem statement and objectives of this research. Scopes and significance of research were also included in this chapter.

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